



Three Dimensional Sub-Surface Imaging Synthetic Aperture Radar



Developer: Mirage Systems, Inc.
Contract Number: DE-AR21-93MC30357
Crosscutting Area: CMST

Subsurface
Contaminants
FOCUS AREA

Problem:

Therefore, new non-invasive detection techniques are needed that will be cost effective, user friendly, and have a growth path toward a system capable of accessing remote terrain. These detection methods must be economical to use and be capable of exploring large land areas quickly with minimal personnel risk. They should provide the precision for identifying the size, depth, type, and possibly the condition of the waste containers.

Solution:

Develop a novel Ground Penetrating Radar (GPR) system capable of remotely detecting, analyzing, and mapping, from a mobile platform, waste containers buried to a depth of ten meters. This system will resolve key technological shortcomings in conventional GPR systems and allow operation with ground conditions otherwise difficult to assess. The three-dimensional underground imaging techniques being developed will help solve waste remediation problems in a more efficient and safer manner than currently available.

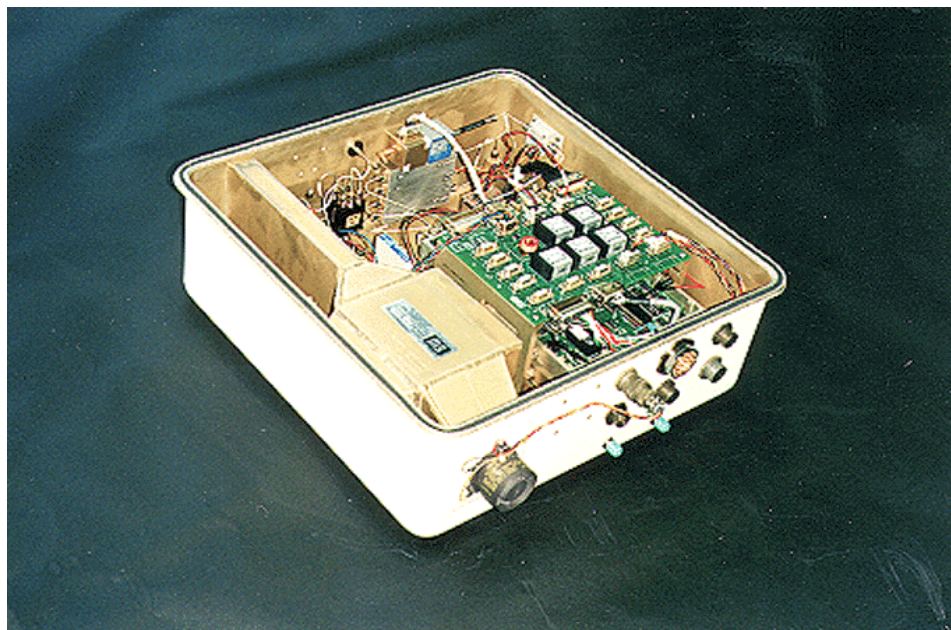
Benefits:

- ▶ Will produce three-dimensional images of the underground environment from which remediation strategies can be derived
- ▶ Should also be useful to characterize the digface as remediation operations progress, and provide data for monitoring sites after remediation
- ▶ Will permit a rapid survey of a site and achieve a high degree of productivity over large areas
- ▶ Standoff technique can overcome

practical survey limitations encountered at vegetated sites

Technology:

The approach employs a spotlight-mode, focused Synthetic Aperture Radar (SAR) to achieve a high-resolution, wide-area characterization capability. In a spotlight-mode SAR, the area to be surveyed is "spotlighted" or "stared at" as the radar's motion forms the synthetic aperture, typically a circle. When compared to the more conventional SAR mapping technique using a raster scan, the spotlight mode enhances spatial



resolution and increases the energy used to illuminate the ground, which improves sensitivity. The ultra-wide bandwidth of the signal improves resolution in the depth dimension as well.

The high SAR coherent integration gain, when combined with the increased sensitivity of the frequency modulated, continuous wave (FMCW) signal transmission method, yields significant improvements in imaging ability. These features are very beneficial for subsurface characterization since 1) long wavelengths, which typically produce images with limited spatial resolution, are needed to penetrate the ground, and 2) the subsurface has inherently high propagation losses requiring more focused energy for effective ground penetration.

A set of signal processing filters whose characteristics are matched to the objects of interest are employed for object detection, recognition, and localization. This correlation technique helps filter out surface and below-ground clutter through the enhancement of the desired objects.

Project Conclusion:

This project was completed in December 1995. At completion, the technology developer succeeded in producing a 3-D image of a buried test object and demonstrated the capability of the technology to detect and locate shallow buried objects in a standoff mode of operation. The project was discontinued at the end of the base contract period due to lack of DOE need for this

technology, given the advancing development of other instruments for similar applications.

Contacts:

Mirage Systems specializes in the design, test, and manufacture of radar systems for unique applications involving precision measurement and calibration. These technologies are being applied to develop high quality 3-D imaging radars for environmental restoration applications. For information on this project, the contractor contact is:

Principal Investigator:
Mr. Kenneth L. Ford
Mirage Systems, Inc.
757 Maude Court
Sunnyvale, CA 94089
Phone: (408) 752-1600
Fax: (408) 734-8845
E-mail: None

DOE's Federal Energy Technology Center supports the Environmental Management - Office of Science and Technology by contracting the research and development of new technologies for waste site characterization and cleanup. For information regarding this project, the DOE contact is:

DOE Project Manager:
Mr. C. Edward Christy
Federal Energy Technology Center
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
Phone: (304) 285-4604
Fax: (304) 285-4403
E-mail: cchris@fetc.doe.gov

